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The GPS Arrow: A Revolutionized Arrow System for Bow Hunting

Physical/engineering/computer/mathematical

STEM BUSINESS PLAN

Elevator Pitch: The GPS Arrow is an efficient method of tracking prey for bow hunters worldwide. This arrow system consists of GPS technology to decrease the amount of animal meat wasted. As this innovational technology evolves, a new level of competition and opportunity is created among bow hunters.

Part 2. Executive Summary: The GPS Arrow relieves bow hunters from the strenuous and frustrating process of animal tracking. This revolutionized arrow system allows hunters to track an animal through a tracking app on their smart phone. The GPS Arrow is a complex GPS arrow system which allows hunters to track the animal due to a small “washer-like” ring that contains a GPS. The ring with the GPS is located on the nock of the arrow. The intricate ring is constructed of a strong, lightweight metal known as titanium. Also located on the titanium ring, are small “burr-like” hooks which will attach to any subcutaneous membranes within the animal. Once the bow hunter locks the arrow nock into the nocking point, the modified nock will click and release. It will then dislodge completely when it penetrates the animal. After the hunter locks the nock into the locking point of the bow, it will release a small amount of surface area. This surface area allows the nock to eject off of the arrow if the circumstance is necessary. If the arrow goes completely through the animal, the titanium burrs of the ring located on the nock, will attach to the animal’s subcutaneous membranes. If the arrow does not go completely through the animal like most situations, the nock will still be intact with the arrow, allowing the hunter to track the animal.

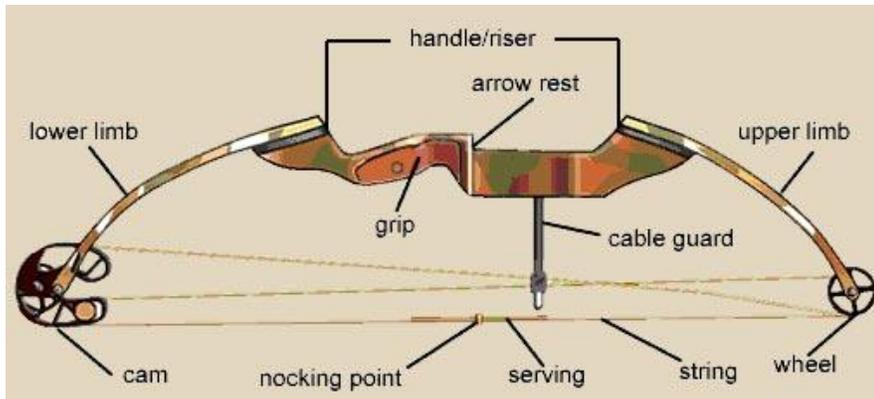


Figure 1. Diagram of a compound bow that shows the components of a bow. The nocking point is shown above.

http://ppvbakbq5j-flywheel.netdna-ssl.com/wp-content/uploads/2014/09/compound_bow.jpg

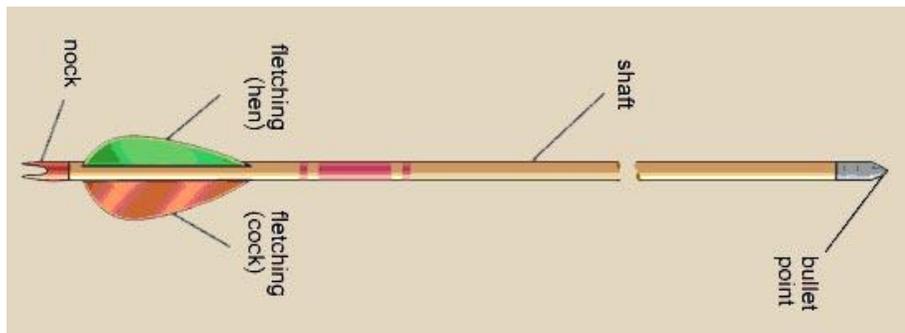


Figure 2. Diagram of basic arrow components. The nock of the arrow, which contains the GPS microchip is show above.

Note: the actual GPS portion of the nock is not shown above. http://ppvbakbq5j-flywheel.netdna-ssl.com/wpcontent/uploads/2014/09/compound_bow.jpg

Part 3. Problem Summary and Proposed Solution: In rural Ohio, hunting white-tailed deer is a popular activity many individuals enjoy. Along with hunting with guns, bow hunting is a common hunting technique used among many hunters. Dwight Schuh, bow hunter activist and author of “Fundamentals of Bowhunting,” states that bow hunting provides a better opportunity for hunters: “Perhaps a reason for bowhunting more prevalent than challenge is opportunity. Some states have more generous rifle seasons than bow seasons, but that’s rare. In most cases, bow seasons are far more liberal. In many Midwestern states, bow seasons run three months or longer, compared with gun seasons of ten days or shorter. Hunting with a bow often allows you to take additional deer each year. (Schuh, 1991). Bow season lasts longer than gun season providing hunters with an extended time period where hunters are capable of using the GPS Arrow. One of the common problems deer hunters, along with any type of hunter, is losing

track of the pursued animal. A contributing writer from “Outdoor News,” reiterates the common problem involving deer hunting:

Some of the most memorable deer I’ve shot were not deer I harvested. There haven’t been many, but there have been a couple of deer I have shot and not recovered. That fact weighs on me to this day. I’ve relived my shot placement, questioned if I should have taken more time and waited for a better shot or whether we could have done a better job of tracking. No sportsman wants to lose a deer, but unfortunately it happens on occasion.

Ideally, we make the perfect shot and the deer drops in its tracks. But that doesn’t happen all the time, especially with archery gear. More often, the deer takes off at the shot and the tracking process begins. (Gnatkowski, 2014)

Not only is the meat of the animal wasted, but the hunters become irritated with this conundrum. Gnatkowski relates to many other hunters who have experienced this overwhelming problem.

These problems could potentially vanish with the GPS Arrow. The GPS Arrow is a tracking system that allows hunters to simply track the animal when it is penetrated with the arrow. Once the animal is hit with the arrow, the GPS unit is lodged inside of the prey. Even if the animal runs for several hundred yards after being hit, the GPS would be able to track the animal. After purchasing and downloading the phone application for the GPS Arrow, hunters will have easy access for animal tracking. With revolutionary technology the amount of time a hunter would spend tracking the animal would be decreased. Many hunters will be relieved to utilize this time saving technology. The anxiety of losing an animal would no longer be a common dilemma. Instead, the animal could be successfully be harvested.

Part 4. Summary of STEM Concepts and Principles Underlying the Overall Plan: In some circumstances, bow hunters struggle to find their prey because of a small blood trail. This can be frustrating to hunters because the hunter loses meat, but also wastes time due to tracking a miniscule blood trail. All of these frustration will be resolved with the use of the GPS Arrow.

By enhancing mechanisms on a regular arrow, the GPS Arrow will eliminate countless problems bow hunters encounter. Many components of the STEM concepts will be used in the GPS Arrow system. These concepts include the following: aerodynamics, weight, velocity, structure of an arrow, and other important factors that influence the GPS Arrow’s ability to function. These areas of the STEM science would need to be tested and sculpted for the best use of the arrow system.

This altered arrow system has been designed so the arrow’s flight pattern and aerodynamics will not be affected. According to Brian Dunbar, an official writer of NASA, states: “Aerodynamics is the way air moves around things.” Perfecting the aerodynamics of the arrow is parallel to the feasibility of the arrow system. The aerodynamics of an arrow has a direct relationship to the weight of the arrow. Since the weight of the GPS Arrow is altered, due to the increased amount of components on the arrow, the GPS Arrow is specifically manufactured so the aerodynamics and flight pattern are not disrupted. Although components are added to the arrow, these components are light in weight and will not have a great impact on the flight pattern. To maintain the light weight of the arrow, titanium is used to minimize the added weight. The particular broad head that is used is shaped and altered so it benefits the flight pattern instead of altering the spiral travel of the arrow. The broad head is specific for the velocity of the arrow, so wind resistance does not become a threat to the arrow’s effectiveness. The fletching on the arrow is also designed for wind conditions. Since the GPS microchip is located at the end of the arrow near the fletching, the fletching is also altered for the arrow’s benefit. The arrow is precisely weighted so the GPS chip will not affect the intentions of the arrow. With specific adjustments to the arrow system, these alterations will not allow any problems to occur with the velocity of the arrow, weight, and arrow structure. The materials used in establishing this revolutionary technology will be for the hunter’s benefit and transform a basic arrow system.

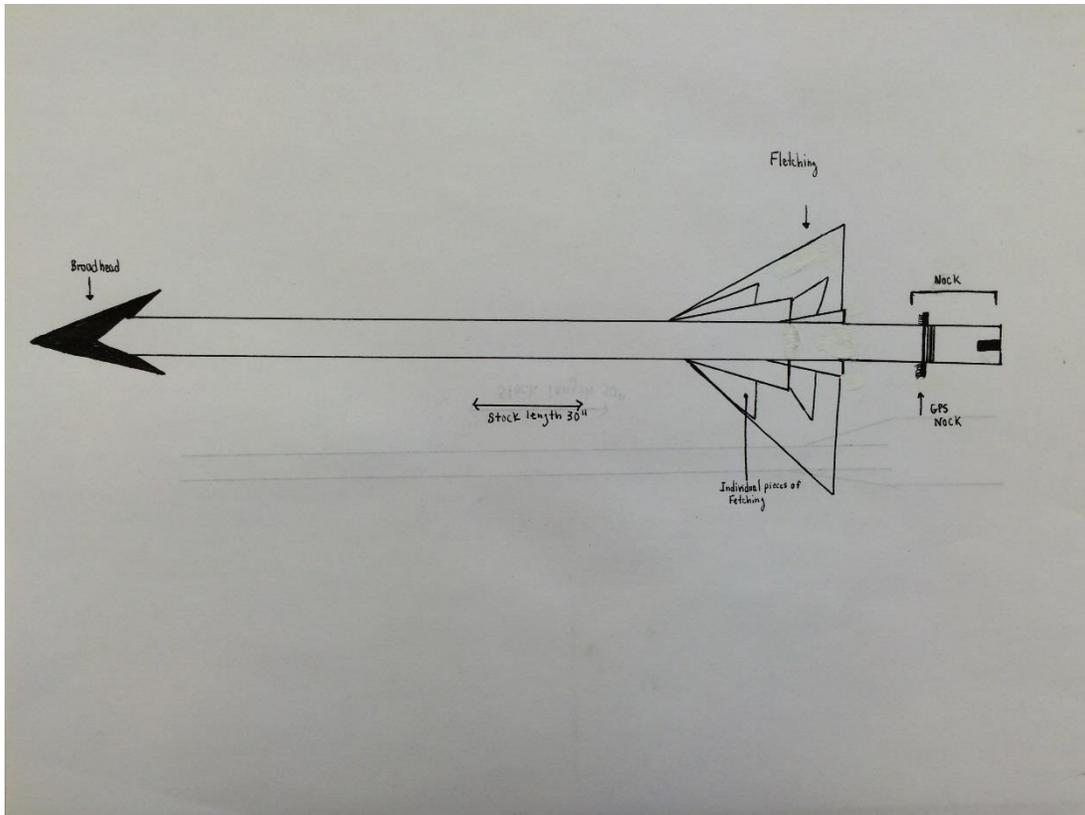


Figure 3. Sketch of the GPS Arrow. This sketch includes the broad head, stock of the arrow, fletching, and the modified nock.

The GPS Arrow is similar to other companies such as Apple who use GPS technology in cell phones and other electronics. GPS has been used by the military for many years. This has allowed the military to help track soldiers, as well as position the enemy. Satellites have also been used for these same reasons. The global positioning system has benefited people for many years and will continue to be used. As technology grows, the understand and capabilities of this technology also advances.

Part 5. Commercialization Assessment of the Overall Plan:

Problem, pain point or market opportunity: Every year hundreds of animals are killed and are not retrieved. These animals are sometimes hard to find because of the hunter's poor tracking skills or a small blood trail. Doug Howlett, author of "How to Blood Trail and Track Wounded Deer," states that "Blood is the best evidence of how well a deer is hit, and often provides the most visible trail to recovering the animal." Many hunters have trouble tracking deer for this issue. A hunter for 30 years, Todd Wilson, states "I've been hunting all of my life, and I have run into situations where I couldn't find a good blood trail. The trail is essential to finding the deer. A GPS arrow would benefit bow hunters everywhere." Wilson, and many others, experience this frustrating reoccurring issue. The GPS Arrow would help people all over the world track and locate their prey. In many situations people struggle to find the animal that the hunter has shot. The arrow system will not only help people find the prey, but also reduce the amount of animals that are wasted. Because of this great technology, bow hunters are not the only people who would benefit from this arrow system. Many benefits can originate from this technology. The Ohio Department of Natural Resources would also benefit from this technology. The environmental organization would be able to track the kill percent of deer more easily, creating better estimates for the deer population. The GPS Arrow will not only provide as a better tracking tool for bow hunters, but is also a more precise way to regulate the deer population.

Proposed solution: All of these problems will vanish with the special engineering of the new GPS Arrow. The GPS Arrow is a complex arrow system which allows hunters to track the animal after it has been penetrated with an arrow. The GPS Arrow has a small GPS tracking device that allows hunters to track the animal to where it has dropped. The GPS signal is sent to a satellite, which then provides a distinct location for the hunter. This location is easy to find by the use of the inexpensive smart phone application. This system eliminates the tracking problem

many hunters face each year. With special technology, this arrow system will change the way hunters recover prey for years to come.

Target customers and intended users: The GPS Arrow system will targets large hunting stores such as Cabelas, Bass Pro Shops, or local stores such as Fin, Feather, and Fur Outfitters. At these stores, bow hunters can view a sample of the product. This will insure the customer of the great quality and feasibility of the arrow technology. The system would also be intended for independent buyers who choose to purchase the product online or eventually in the company’s store. Large hunting stores are the primary location where the units will be sold. The equipment will be available for anyone who is permitted to purchase hunting weapons legally. To target customers, the GPS Arrow will be on display at many hunting conferences and will have recognition on hunting blogs and in stores. Online forums will also advertise the technology of the GPS Arrow. Popular hunting magazines and news articles such as “Outdoor Life,” “Outdoor News,” “Field and Stream,” and “North American Whitetail” will advertise the GPS Arrow.

Competitors: The GPS Arrow system is the first type of arrow system created with a GPS inside of the nock of the arrow. However, an arrow system has been patented known as the RFID Arrow Tracker. This arrow system includes RFID technology within the broad head of the arrow. The flaw in this system is the possibility of the broad head completely passing through the animal. Thus, leaving the hunter unable to track the animal. Other competitors are Easton Archery Stalker Arrows and Gold Tip Pro Hunter Arrows. These arrows do not include GPS capabilities and come with basic arrow qualities as shown on Table 1.

With the GPS Arrow, the GPS unit is attached to the nock of the arrow. Once the arrow completely penetrates through the skin, the nock will disconnect from the arrow leaving the tracking device inside the animal. If the arrow does not completely pass through the animal, the arrow would still be inside it. The GPS unit would still be attached to the animal even if the nock has not reached the subcutaneous layers of the animal. If the arrow would go completely through the membrane of the animal or would be stopped from possibly hitting bone, the GPS unit can still be used. The GPS Arrow will easily outperform any other competitors because of its revolutionary and precise technology and its ability to be custom designed.

	Arrow Name:	GPS Arrows	RFID Arrow Tracker	Easton Archery Stalker Arrows	Gold Tip Pro Hunter Arrows
Quality of Arrow					
GPS Capabilities		X			
Made of Carbon		X			X
Made of Aluminum		X		X	
Price		126.47/ 2 arrows	Not listed	24.99/6 arrows	84.99/ 6 arrows
Comes with smart phone application		X			
Sold online		X		X	X
Sold in stores		X		X	X
Tracking technology		X			

Patent/ Provisional Patent	X	X	X	X
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Table 1. This table compares the competitive qualities of the GPS Arrow to other leading arrow brands.

Customer value proposition & competitive advantage: Since GPS Arrow system does not use the RFID technology and it has more than basic arrow qualities, it would far exceed any customer's expectations. According to United States Patent and Trademark Office, the GPS Arrow is completely original and patents do not exist for this type of hunting technology. After searching for possible trademarks, research has shown that there are no documented patents of this type. Unlike the RFID Arrow Tracker, the GPS Arrow uses satellite communication to project its signal. The GPS unit within the nock of the arrow, uses minimal energy, therefore does not need a power source like other GPS units. The signal is projected directly through the unit to give off a precise location signal. The GPS Arrow has a competitive advantage over other arrow companies because of its original, advanced bow hunting technology. Since the GPS is placed in the nock of the arrow, instead of the broad head, hunters will still be able to track their pray if the arrow goes completely through the animal. The renovated arrow system will easily compete with any other potential competitors. Another competitive advantage of the GPS Arrow is that the system competes with other companies so that the costs of the GPS Arrow stay relatively low. As shown in table 1, the GPS Arrow has many qualities that other arrows do not have. The GPS Arrow has GPS technology abilities, it can be customized to be manufactured of carbon or aluminum for the hunter's preference, the cost of the arrows includes the smart phone application, it is sold in stores and online, and the GPS arrow system has tracking technologies unlike any other arrow system. The price of the arrow system is very reasonable to customers. Other arrows costs as much as \$89.99. The GPS Arrow system's markup is only 50% of the products worth. Because of the arrow's great technology and originality, a provision patent is being processed in April of 2016.

The RFID Arrow Tracker has not been sold, but a patent has been created for the RFID technology in the broad head of the arrow. Other arrows such as the Easton Archery Stalker Arrows and the Gold Tip Pro Hunter Arrows are not customizable and only come in the company's choice of aluminum or carbon. Although each arrow set is sold online and in stores, the arrows do not have tracking technology to enable hunters to find deer more easily. Each arrow system listed in table 1 has or is in the process of patenting the companies' arrows.

Principle revenue streams expected: The principle revenue stream expected for the first year of the GPS Arrow system is \$7,499.00. Each arrow system will sell for \$126.47. This cost includes a set of two customizable arrows and the smart phone application. The cost to manufacture the arrows is \$30.37. This generated revenue is composed of reasonable numbers and the company's high demand for the product.

Principle startup and operating costs expected to be incurred: While starting a company, several operating costs and startup principles have to be met. The company will start its business in a finished pull barn and eventually grow into a warehouse. In the first three quarters the company will be building its accounts to finance for the pull barn. By the fourth quarter the company will have \$28,372.00 in total costs and expenses. These costs include initial costs such as the cost to manufacture sales, selling, marketing and advertising costs, space and occupancy costs, management costs, and other expenses.

Part 6. Business and Financial Proof of Concept:

The GPS Arrow system is not only original, but highly marketable. Hunters from across the world will invest in this revolutionary technology. Since this technology is new, companies from around the world would want to invest in this technology to offer to customers. In the beginning of marketing process, the arrows will be sold to smaller businesses and companies, which will then lead larger companies to invest in the equipment. Social media will also play a great role in advertising the GPS Arrow. With the help of Twitter, Instagram, Facebook, and internet forums, the word will spread quickly of the GPS Arrow. The GPS Arrow will be mentioned on hunting websites and blogs. After popular outdoor magazines such as "Field and Stream" or "North American Whitetail" acknowledge the feasibility of the new technology, hunters from across the world will want to obtain the GPS Arrow. The arrows will be available to be sold at hunting conferences, and eventually this will increase people's knowledge of the technology. Samples will be given to stores like Cabelas, Bass Pro Shops, and Fin, Feather and Fur Outfitters. The GPS Arrow will be advertised on the radio, and also at trade shows throughout the year. Conferences like the Ohio Hunting Expo will also help advertise the product. Thankfully, with the high use of technology today, the publicity for the GPS Arrow will grow quickly, helping the costs of the company's advertising.

A high demand will be set for the GPS Arrow. By keeping the arrow system's price low, people from all financial circumstances will be able to purchase the equipment. Once people recognize the high quality of the arrow system, demand for the arrows will increase, creating greater profits. The application for smart phones will cost \$4.99. This will be included when the customer purchases his or her initial arrow system. Once the hunter purchases their initial arrow system, he or she will have their own account. Within the account, customers have the ability to add more arrows by their serial number, and the application will track these arrows as well. This way the customer will only have to purchase the application once, saving the customer money. The arrows will be able to be purchased in customizable sets of two, also saving the customer money. Replacement arrows will be cheaper for the customer, and easy selection for the replacement arrows will be available. This competitive pricing will far exceed the customers' expectations and will be highly competitive for any upcoming companies. The GPS Arrow system's full price for a complete set of arrows and smart phone application is currently \$126.47. The cost for a replacement set of arrows is \$120.00. The company does not expect to gain any annual earnings until the third year of manufacturing.

To start manufacturing the product, a complete prototype will be needed to be created. The GPS Arrow's prototype will be created then repeatedly tested for best functionality for the customer. The company focuses on high quality products. The product will be manufactured in a small facility, then will eventually grow into a large company. This product will be manufactured by its creators and the prototype will not be distributed for other companies to manufacture. The protected rights and provisional patent of the product will limit any potential competition. All outside processing or creating for the GPS Arrow will be within the company's budget and will eventually grow with the earnings. To begin the process of manufacturing this product, a prototype will be needed to be created then eventually followed with a detailed patent. The product will be created and morphed with the help of the GPS Arrow company founders and investors.

To begin the process of manufacturing the GPS Arrow, the inventors will need to create a basic prototype then eventually a detailed prototype which will lead into a patent. The patent would prohibit anyone from copying the company's ideas and plans. After the creation of the patent, loans will be needed to be taken out to start creating the technology or investors will help with the costs. After the creation of the product, publicity will increase, also increasing revenues, building the company. Preparing a company to manufacture a product that will bring in high demand will not only take a lot of effort from the inventors, but will also be costly. The estimated cost for materials, labor, and to help distribute the product will be \$30,122.00 for the first year. To initially start up a business or small company, the costs are going to be high. When the company is just beginning to be established, there will be very minimal employees. All extra costs will be kept at a minimum until the company begins to grow. Preorder sales will also be taken to help with the initial startup costs of the business. This will not only help the company's costs, but allow customers to have the product as soon as it is manufactured. This will keep the startup costs low, but also help build future profits.

By inventing a product, the inventor is also creating many uncertainties. The inventor cannot be guaranteed people will purchase the product. However, the GPS Arrow would be a product that is high in demand. Hunters encounter issues every day that would be eliminated with the help of the GPS Arrow. Hunted animal waste would be minimized with the arrow system. Losing track of an animal due to the lack of tracking abilities or lack of blood occurs often among hunters. The GPS Arrow would help eliminate the possibility of losing track of animals and help resolve the reoccurring issue. The competitive risk is completely understood in inventing this product. The company realizes competition could arise, and challenge the GPS Arrow's abilities. The product is very competitive itself, and will not allow other companies to mimic its technology. The cost of the product can easily be delivered with the quality at a low cost. Since technology is advancing so quickly, the products can be manufactured at low costs, keeping the overall cost of the product at a minimal rate. Human resources will be kept a minimum while the company is growing to keep costs down. Materials and suppliers will be utilized in low numbers until the company's growth has reached its appropriate size. By securing loans, and having investors, financial resources can be met. Government regulations have already been set for who can and cannot purchase weapons. The legal liability risk will be controlled so issues can be easily maintained.

Three year financial projection: For the first quarter of manufacturing, sales are intended to be low. After publicity increases, and the quality of the product is known, people will start to purchase more of the product. During the first quarter, there will not be any sales or revenue due to the company building its financial state from preorders and investments. Again, for the second quarter there will not be any sales and revenues. Sales are expected to grow quickly after people realize the ability this technology has and the affordability of the product. During the third quarter there will still not be any sales and revenues. After people are aware of the product, people will quickly purchase the item and realize the product's great quality. By the fourth quarter, the company will sell 60 units,

earning \$7,499.00. These earnings will go to pay off initial operating costs, so the company will not have net revenues. By year two, the company will sell 95 units, growing by 58.33% and earning \$11,974.00 to pay for the business's initial operating costs. By year 3, the company will sell 158 units, growing by 66.32%. The company will make \$19,748.00 and after paying for the company's cost will finally make \$1,550.00. Selling, marketing and advertising costs are expected to be kept at a minimum while the company is growing. Many start-up costs are expected to incur during the beginning of the company. The expected marketing programs, advertising costs, are predicted to be around \$150.00 per quarter. With the help of social media, the recognition of the product will easily be transferred to the public.

Space and occupancy costs are predicated to stay low for the first couple years of the business. The company will not have space and occupancy costs until the fourth quarter after building a finished pull barn. This cost will be \$25,000.00 and will only be an initial cost.

Management and administrative costs will be very low for the first couple years. The company will only have a few workers and volunteers specific to the area needed to be researched and created. The owner of the company will only be paid the fourth quarter earning \$1000.00. This earning will be increased as the business's industry increases. By year three, the owner of the company will be making \$4,000.00. The following year the owner will also be making \$4000.00.

The costs of sales will not take effect until the fourth quarter when the company will be processing and making the GPS Arrow systems. This will include preorders, store orders, and online orders. The company will only keep a 30% inventory to maintain low costs. This inventory is also low because customers have the ability to customize arrow systems. To construct the arrows, costs were figured by averages GPS unit costs, average costs of shafts, nocks, and titanium washers. The GPS chip costs range from \$2.00 to \$15.15, averaging \$8.57. Shafts of the arrows range from \$2.00 to \$6.00, averaging \$4.00. Titanium washers average about \$2.50. In conclusion, with all costs of manufacturing and constructing, a single arrow with the GPS technology within the nock of the arrow costs \$30.37. This cost is very low and hunters would easily spend the extra money to purchase the technology to make tracking more efficient. The GPS Arrow is marked up by 50.00% to cover other costs related to manufacturing. This would total to \$60.74 per arrow. Since the company will be selling the arrow in sets of two, the arrow price would be 121.48. Then \$4.99 will be applied to this cost totaling the price to be 126.47. This cost is very low considering bow hunters spend money traveling to animal populated hunting areas, hundreds of dollars on taxidermy, and thousands of dollars on guns, bows, and ammunition. This technology would be very beneficial for bow hunters who want to make animal tracking more efficient, while using revolutionary hunting technology.

Part 7. Acknowledgements:

The following people helped contribute to the GPS Arrow system. Joe Kiefer, the author's father, helped finalize ideas for the project. Beth Wilson, the author's mother, helped edit the business plan. Grant Kiefer, the author's brother, provided constructive criticism. Ron Kiefer, the author's grandfather, provided arrows for research. Todd Wilson, the author's step father, provided knowledge and personal experience to help sculpt ideas. Mr. Miller, a STEM teacher at Loudonville High School provided ideas and suggestions for the GPS Arrow. Mr. Weber, a physicist and chemistry teacher at Loudonville High School, assisted the author with resources for research. Loudonville Public Library, helped by providing many different reference books and resources. Mrs. Young, Loudonville High School's Librarian aid, directed the author for reference materials. Mr. Seth Youngen, Loudonville High School's finance and entrepreneurship teacher, provided instruction throughout the project. Mr. Eric Stoner, Loudonville High School's government teacher aided to the pensive investigation. And Mr. Pete Snyder, Loudonville High School's 11th grade English and film teacher helped edit the business plan.

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Business Plan Name		The GPS Arrow: A Revolutionized Arrow System					Revised August 2013			
Financial Projections		For the First Four Quarters and First Three Years								
Number of units sold		0	0	0	60	Totals For	95	158		
		Quarter 1	Quarter 2	Quarter 3	Quarter 4	First Year	Year 2	Year 3		
Sales and revenues		\$0	\$0	\$0	\$7,588	\$7,588	\$12,015	\$19,382	Price of item:	126.47
% Growth		#DIV/0!	#DIV/0!	#DIV/0!			58.33%	66.32%		
Costs and expenses:										
Cost of sales		\$0	\$0	\$0	\$1,822	\$1,822	\$2,885	\$4,798	Cost to Make	30.37
Selling, marketing and advertising costs		\$250	\$150	\$150	\$150	\$700	\$800	\$800		
Space and occupancy costs		\$0	\$0	\$0	\$25,000	\$25,000	\$5,000	\$5,000		
Management and administrative costs		\$0	\$0	\$0	\$1,000	\$1,000	\$4,000	\$4,000	% of Inventory	30%
Other costs		\$400	\$400	\$400	\$400	\$1,600	\$3,600	\$3,600		
Total costs and expenses		\$650	\$550	\$550	\$28,372	\$30,122	\$16,285	\$18,198		
Pre-tax cash profit (loss)		(\$650)	(\$550)	(\$550)	(\$20,784)	(\$22,534)	(\$4,270)	\$1,184		
Investment required to start your business:						Year 1	Year 2	Year 3		
Working capital: Operating cash (Cover 3 Months of Expenses for the GPS Arrow)						\$3,115	4,071	4,550		
Accounts receivable (1% of the overall total sales)						\$76	120	200		
Inventory (Lean Manufacturing- 20% cost of sales)						\$547	866	1,440		
Other current assets						\$1,000	800	800		
Office equipment						\$4,000	4,000	2,700		
Warehouse & manufacturing equipment						\$18,000	10,000	10,000		
Building or leasehold improvement costs						\$12,000	3,000	8,000		
Cost of developing prototype products						\$30,000	5,000	3,000		
Legal, patent or other organizational costs						\$15,000	3,000	3,000		
Initial start-up losses that must be funded						\$15,000	6,000	6,000		
Other investment costs						\$1,000	6,000	6,000		
Projected total investment						\$105,738	\$48,857	\$45,689		
Projected return on investment (Profit/Investment)						-21.3%	-8.7%	3.9%		

Table 2. This table is the Financial Projection Schedule and shows all financial numbers regarding the GPS Arrow system.